



Designation: D413 – 98 (Reapproved 2017)

Standard Test Methods for Rubber Property—Adhesion to Flexible Substrate¹

This standard is issued under the fixed designation D413; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These test methods cover the determination of the adhesion strength between plies of fabric bonded with rubber or the adhesion of the rubber layer in articles made from rubber attached to other material. They are applicable only when the adhered surfaces are approximately plane or uniformly circular as in belting, hose, tire carcasses, or rubber-covered sheet metal.

1.2 When the adhered surfaces contain sharp bends, angles, or other gross irregularities that cannot be avoided in preparing test specimens, special test methods must be employed for evaluating adhesion.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

D3040 Practice for Preparing Precision Statements for Stan-

dards Related to Rubber and Rubber Testing (Withdrawn 1987)³

D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets

D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products

3. Summary of Test Method

3.1 Two general test methods are given:

3.1.1 *Static-Mass Method*, in which the force required to cause separation between adhered surfaces is applied by means of gravity acting on a mass.

3.1.2 *Machine Method*, in which the force required to cause separation between adhered surfaces is applied by means of a tension machine.

3.2 Except as may be otherwise specified in these test methods, the requirements of Practices D3182 and D3183, shall be complied with and are made a part of these test methods.

3.3 In case of conflict between the provisions of these test methods and those of detailed specifications or test methods for a particular material, the latter shall take precedence.

3.4 As covered by these test methods, an adhesion test consists of applying to a test specimen, under specified conditions, a (measured) force sufficient to strip from the specimen at a measured rate, a layer of moderate thickness with separation (rupture, tearing) at the adhered surfaces. The numerical value of the adhesion is expressed as (1) the average force required to cause separation at a definite rate, or (2) the average rate of separation caused by a known or specified force. In the machine test method, the rate of separation is fixed and the adhesion value must be expressed in terms of the measured force. With the static-mass test method, either (1) or (2) can be used, but the latter is preferable and will be here employed.

¹ These test methods are under the jurisdiction of ASTM Committee D11 on Rubber and Rubber-like Materials and are the direct responsibility of Subcommittee D11.25 on Rubber Adhesive Systems.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

4. Significance and Use

4.1 These test methods are used to ensure the quality of a product by determining the force per unit width required to separate a rubber layer from a flexible substrate such as fabric, fibre, wire, or sheet metal. The acceptable value of adhesion measured will, of course, vary from product to product due to different rubber formulations, flexible substrates, and types of products. However, once a product is established, minimum values of separation force can be determined and agreed to by producer and consumer and both can monitor to assure maintenance of the agreed-upon minimum value.

STATIC-MASS METHOD

5. Apparatus

5.1 The apparatus required for the adhesion test by the static-mass test method consists of a supporting frame, testing clamps, mandrels, calibrated masses, and mass carriers. The supporting frame is of such design that clamps for strip specimens hang on it vertically and that mandrels for ring specimens are supported on it horizontally. The frame has sufficient height to permit the mass carrier to be suspended from the test specimens by means of clamps and to hang freely during the progress of the test. Provision also is made to support the mandrels so that they revolve freely with minimum friction. Suitable apparatus is shown in Fig. 1 and Fig. 2.

6. Test Specimens

6.1 *Strip Specimens—Type A*—Plane strips having a width of 25 ± 3 , -0 mm (1 ± 0.125 , -0 in.), and a minimum length such as to permit 180° peel separation over sufficient distance to indicate the adhesion value.

6.1.1 Cut the specimen to 25 ± 3 , -0 mm (1 ± 0.125 -0 in.) wide. The thickness will vary according to the construction of the article being tested. The maximum thickness of the specimen is limited to 13 mm (0.5 in.). To comply with this requirement, slice or buff the specimen. The ply or layer being separated should never be over 6.5 mm (0.25 in.) thick.

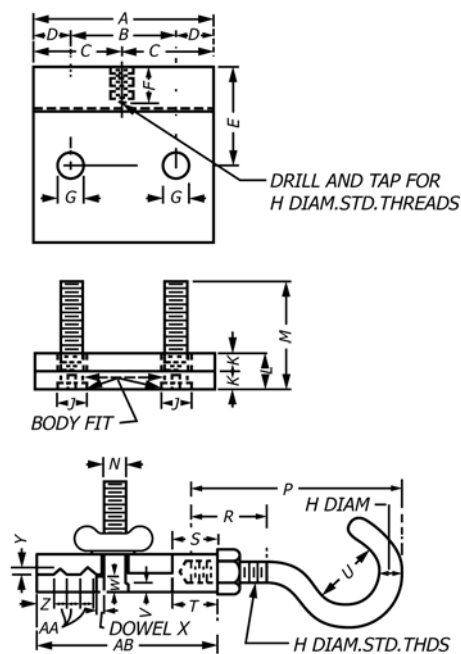
6.1.2 Cut the specimen from the article in such a manner that the adhered parts have the same width where practicable. The technique used in 6.2.2 and 6.2.3 may be applied here. When necessary, or specified, cut only the layer to be separated (by application of load) to the prescribed width. In such cases, remove the portions of that layer remaining outside of the test width to avoid edge constriction during separation.

6.1.3 Curved specimens for test in strip form shall have curvature only in the length dimension of the specimen.

6.2 *Strip Specimens—Type B*—The same as Type A, with the exception of 90° peel and the separation line in the center of the specimen.

6.2.1 Cut the specimen 35 mm ($1 \frac{3}{8}$ in.) wide. Remove the excess plies to obtain a thickness of 6 mm ($\frac{1}{4}$ in.) and leave the separation line in the center of the specimen to ensure a 90° peel.

6.2.2 Buff to a width of 30 mm ($1 \frac{1}{8}$ in.) with a coarse grit emery cloth (grit No. 40) with care to prevent burning or gumming the sides of the specimen.



Dimension	mm	in.	Dimension	mm	in.
A	75.0	3	N	10.0	$\frac{1}{8}$
B	45.0	$1\frac{1}{4}$	P	90.0	$3\frac{1}{2}$
C	37.5	$1\frac{1}{2}$	R	30.0	$1\frac{1}{4}$
D	15.0	$\frac{3}{8}$	S	20.0	$\frac{3}{4}$
E	40.0	$1\frac{11}{16}$	T	18.0	$\frac{23}{32}$
F	15.0	$\frac{1}{8}$	U	30.0	$1\frac{1}{8}$
G	10.0	$\frac{11}{16}$	V	3.0	$\frac{1}{8}$
H	11.0	$\frac{13}{32}$	W	6.0	$\frac{1}{4}$
J	13.0	$\frac{1}{2}$	X	3.0	$\frac{1}{8}$
K	8.0	$\frac{1}{16}$	Y	3.0	$\frac{7}{64}$
L	16.0	$\frac{3}{8}$	Z	8.0	$\frac{5}{16}$
M	50.0	$1\frac{1}{8}$	AA	6.0	$\frac{7}{32}$
			AB	75.0	3

FIG. 1 Clamp for Adhesion Test

6.2.3 Make a 2-mm ($\frac{1}{16}$ -in.) deep slit with a knife along each side exactly where the specimen is to be separated during testing. Use a knife with an adjustable blade where only the desired depth of cut (2 mm) of blade is exposed.

6.3 *Ring Specimens*—Closed rings having a width of 25 mm (1 in.) and maximum internal diameter of 100 mm (4 in.).

6.3.1 Mount the article on a smooth, close-fitting, slightly tapered wooden mandrel.

6.3.2 Rotate the mandrel (a lathe is preferred) and cut 25-mm (1-in.) wide ring sections by forcing a sharp pointed knife gradually through the article.

6.3.3 Cut rings with internal diameters over 100 mm (4 in.) through and open to form strip specimens.

7. Procedure

7.1 *Strip Specimen: Type A, 180° Peel*—Measure the width of the strip cut to the nearest 0.2 mm (0.01 in.) and record. Separate the parts to be tested by hand at one end of the strip specimen and at a sufficient distance to permit the jaws of the testing clamp to be attached. Suspend the strip from the supporting frame by the separated end, being sure the jaws of